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"TO PROMOTE ECONOMIC CROP PRODUCTION,
IMPROVE THE QUALITY OF THE PRODUCTS, AND
REDUCE WASTAGE IN STORAGE, TRANSIT, AND AT THE MARKET"

THE CUCUMBER MOSAIC CONTROL PROGRAM

THE EXTENSION PATHOLOGIST

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THE CUCUMBER MOSAIC CONTROL PROGRAM

Control of the Mosaic Disease of Cucumbers in Wicomico County

By J. P. Brown, County Agent,
Salisbury, Maryland.

Mosaic disease of cucumbers during the season of 1926 caused an almost total loss in certain sections of Wicomico County. Some fields inspected during the growing season showed 95% infection. Such fields were almost a total loss and no fruits were picked from them. The loss amounted to about three hundred cars which were worth approximately $100,000.00. In the case of all fields in which the disease was observed during the season of 1926, some infected pokeweeds were found nearby. Fields showing the highest per cent of infection were located near ditches or woods where the wild host plants had excellent chances to grow.

Dr. R. A. Jehle, Specialist in Pathology, and the writer planned to carry on control demonstrations in 1927 with at least six farmers in the county who had suffered the heaviest losses during the season of 1926. In this connection, a meeting was held at the office of Dr. W. W. Gilbert, Bureau of Plant Industry, Washington, D. C. This was attended by Mr. F. C. Meier, Extension Plant Pathologist, U. S. Department of Agriculture, Professor C. E. Temple, State Pathologist, Dr. R. A. Jehle, Extension Pathologist, University of Maryland, and the writer. At this meeting, plans were discussed for control work and a definite program was mapped out.

Six cucumber growers were asked by the writer to cooperate in this work. All of these growers had experienced an almost total loss due to mosaic in 1926, and were extremely anxious to take part in the project. With the aid of Dr. R. A. Jehle, a meeting was held in the Court House at Salisbury and about one hundred farmers attended. Dr. Jehle illustrated his lecture with slides furnished by Dr. W. W. Gilbert and gave definite instructions for control. Mr. P. D. Sanders, Assistant Entomologist, then spoke on control measures for cucumber beetles and plant lice, since these insects are responsible for the spread of mosaic. Mr. S. B. Shaw gave a very interesting talk on marketing of fruits and vegetables and pointed out that the best returns were obtained on produce free from insect injury and disease. He urged all present to put forth every effort to control diseases and insects in their crops. The six farmers planted their fields as usual, but under the supervision of Dr. Jehle and the writer, and all wild plants known to be hosts for the mosaic disease, if found within fifty yards of the fields, were destroyed.

On June 17 the fields were given the first inspection by Dr. Gilbert, Dr. Jehle and the writer. Six fields belonging to the farmers cooperating were inspected as were several other fields nearby.

In one field, no further observations were made because of the poor stand. Two other fields were added making seven farms on which the work was continued throughout the entire season. The following table shows the inspections made and the number of infected plants found:

Inspections -- Number of Mosaic Plants.

Grower	June 17	July 7	July 13	July 27	August 11
Harry E. Rounds	0	0	0	0	3
Chas. Gibbons	0	0	0	0	4
E. L. Vaughn	3	0	16	63	75
Carl Smith	0	0	2	3	3
J.E.Richardson	0	6	6	5	5
W. Oakley	4	30	46	100% infection	100% infection
W. Wheatley	3	1	0	0	0

With the exception of Mr. Oakley, all the growers dug out the poke weed and kept it out during the entire season. Mr. Oakley at the beginning of the season cut down the wild host plants, but they sprouted and infected ones were found later in the season by Dr. Gilbert and the writer.

Mr. E. L. Vaughn destroyed wild host plants, but later in the season sprouts were found. However, he continued to rogue out the infected cucumber vines, as soon as they were seen, and finally the disease seemed to disappear. Another farmer, not cooperating in the work, found that the disease also seemed to disappear after he had carefully rogued out all cucumber vines which appeared to be infected with mosaic. All of the other cooperators rogued out infected plants with similar results, Each cooperator dusted at least once during the season with calcium arsenate and land plaster (one part to nineteen) in order to control the cucumber beetles. This treatment appeared to be very efficient.

In some instances the cucumbers showed signs of infection while the leaves of the plants appeared to be perfectly healthy. Other fields visited appeared to have the vines badly infected with mosaic, while the fruits appeared to be perfectly healthy.

One field belonging to Mr. Carl Smith was planted in the center of his farm, surrounded by cultivated crops and no wild host plants were found nearby. No diseased plants were observed in this field. The other field planted by Mr. Smith bordered his wood lot and about three diseased plants were found. So far as we have been able to determine, the poke weed is the only wild host plant found to be infected with mosaic. Milk weed and ground cherry found near cucumber fields have every appearance of being healthy.

The following returns for 1926 and 1927 were given to the writer by the cooperators:

	1926				1926		
	Acres	Yield (Bu.)	Returns		Acres	Yield (Bu.)	Returns
Farm "A"	1¼	128	$ 94.90		¾	246	$202.69
" "B"	2	373	279.17		1½	545	463.00
" "C"	1	89	58.00		1	636	540.00
" "D"	3	None	100.00	(loss)	1½	819	695.00
" "E"	¾	"	55.00	(")	¾	536	455.00
" "F"	1½	230	150.00		¾	194	165.00

Average price per bushel hamper in 1926 - 65¢
" " " " " " 1927 - 85¢

Summary:	Acres	Yield	Returns
1926	9¾	820 Bu.	$582.07
	Loss		155.00
	Total Returns		$427.07

Yield per acre - 84 Bu.
Returns " " $43.80

Summary:	Acres	Yield	Returns
1927	6¼	2,976 Bu.	$2,520.6

Yield per acre - 476 Bu.
Returns " " $403.31

It will be noted that in every case the yields and returns were much larger in 1927 than they were in 1926. The increase in yield was no doubt due to absence of mosaic this year. Although part of the increased returns was due to better prices, the largest part of it resulted from the control of the mosaic disease in 1927.

To furnish a check on the results secured from the demonstration fields, data as nearly comparable as possible was secured from a farmer not included in the demonstration. His yields and returns are given below:

	1926			1927		
	Acres	Yield	Returns	Acres	Yield	Returns
Farm "G"	1½	209 Bu.	$135.00	1½	230 Bu.	$195.00

The yield per acre in 1926 was 139 bushels; in 1927, 153 bushels. The increase in yield of 1927 crop over 1926 crop was 10% as compared with the average increase in the experimental fields of 466%.

As a result of the meeting held at Salisbury, the distribution of literature, newspaper articles and personal advice, a large number of the cucumber growers in the county destroyed wild host plants and rogued their fields. This resulted in a material decrease of diseased plants and fruits in the county. The loss in 1927 was estimated to be 15% of the crop. The money loss from cucumber mosaic will therefore be greatly reduced this year.

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Cucurbit Mosaic Control a Demonstrated Fact.

The successful outcome of the first cucumber mosaic control demonstration carried out in the Eastern States; details of which are given by Mr. Brown above, gives added confidence that the methods worked out in Wisconsin can be adapted to conditions in other states with a resulting large reduction in the losses now suffered from cucurbit mosaic. As a result, it is probable that other states where mosaic is an important disease will wish to test the control measures in their section.

To assist in this work, a set of 31 lantern slides illustrating the important features of the cucumber mosaic disease with special reference to the wild host plants concerned in the overwintering of the disease has been assembled and an explanatory syllabus prepared by the writer in cooperation with the Office of Cooperative Extension Work.

These slides are intended for use by pathologists, county agents and others who are putting on local demonstrations for cucumber or muskmelon mosaic control and can be procured from the Extension Service of the U. S. Department of Agriculture by communicating with Mr. F. C. Meier. In so far as possible, additional information and assistance in formulating programs for such demonstrations will also be furnished.

It is believed that with thoroughness and care the method can be adapted to most localities and will prove well worth while in the control of mosaic and the consequent increase in the yield.

The same methods should be equally effective in the control of cantaloupe mosaic. In sections where cantaloupe plants are grown in cold frames, and then set in the field, special care should be taken that the plants do not become infected in the frames. In several instances last season severe outbreaks of mosaic in the field were traced directly to the frames where the plants were grown and where mosaic pokeweeds were found, either in or surrounding the beds. Such early infection results in more severe attacks and often in a total loss of crop.

W. W. Gilbert, Pathologist,
Bureau of Plant Industry,
Washington, D. C.

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Data for Plans for Extension Work on the Control of Cucumber Mosaic.

(Supplementary notes for use by County Agents in applying information contained in Department Bulletin 1461, "Control of Cucumber Mosaic by Eradication of Wild Host Plants.")

By S. P. Doolittle and W. W. Gilbert,
Pathologists, Bureau of Plant Industry.

Importance of the Disease.

Cucumber mosaic is the most serious disease affecting this crop in the Central States where a large percentage of the pickling cucumbers are grown, and losses from it are increasing annually. Mosaic is most widely distributed and serious in Michigan, Wisconsin, Illinois, Indiana and on Long Island, N. Y. In these states approximately 8 to 12 or more per cent of all the plants are affected by mosaic each year. The actual losses are perhaps even greater than is indicated by the above figures, since the disease is most prevalent in sections where the yield per acre is greatest. The cucumber acreage in certain sections of these states has also been greatly reduced during the past ten years, as a result of losses from this disease.

In New York, the loss from mosaic on Long Island in 1925 was estimated at 65 per cent. The disease is also known to occur commonly in Ohio, Iowa, Colorado, Virginia, Maryland, Florida and Louisiana. It is also reported from Maine, Massachusetts, Minnesota, Vermont, Connecticut, West Virginia, New Jersey, Pennsylvania, Georgia, Texas, California and Nebraska, where varying degrees of damage are caused.

Facts on Which Control Measures for Mosaic are Based.

1. Cucumber mosaic is a virus disease and is disseminated by insects and by the handling of diseased and healthy plants in picking and training the vines. Insects are the chief means of dissemination, especially the cucumber aphis, striped cucumber beetle and 12-spotted cucumber beetle. The aphis is probably the most important factor in this regard.

2. Cucumber mosaic is not carried over winter by insects and does not live over in the soil. It is not carried in the seed of the cultivated cucurbits to any important extent.

3. Mosaic does, however, live over winter in the seed of the wild cucumber, Micrampelis (Echinocystis) lobata, and is also carried in the roots of certain wild perennial host plants of other families. These are the milkweed, Asclepias syriaca, pokeweed, Phytolacca decandra, two species of wild ground cherry, Physalis heterophylla, and P. sybglabrata, and the catnip, Nepeta cataria. All of these host plants are found before cucumbers are planted in the spring and all are attacked by insects

which also feed on the cucumber.

4. The first mosaic infection on the cucumber occurs as a result of infection from some mosaic wild host through the agency of insects, seed infection being rare. In the case of the wild cucumber the striped beetle acts as the carrier, but in the case of the perennial hosts listed above, the cucumber aphis appears to be the chief agency in the transmission of the disease. The perennial hosts appear to be the most important sources of infection since they ordinarily occur near the fields, but in some sections there appears to be a great amount of mosaic infection which is traceable to the wild cucumber. It is probable that the milkweed, wild cucumber, pokeweed and physalis are all of considerable importance in many localities but the catnip has not been found to be much of a factor in the localities studied in Wisconsin and Illinois.

5. The results of experiments on control of the mosaic disease carried out over a period of four years at points in Illinois and Wisconsin where mosaic has been serious, have been so striking that the methods used are believed to be equally applicable to other localities where the disease is prevalent and severe.

Fields where annually 75 to 100 per cent of the plants were badly affected with mosaic on August 1 to 15, by the method of eradication of host plants advocated, have been carried practically through the picking season to September 1 with only a nominal infestation of 5 to 7 per cent and that occurring too late to affect the crop materially. The amount of labor involved is not great. The result is practically a full crop of healthy cucumbers instead of a partial crop of half mosaic stock. Furthermore, the results are believed to be cumulative. When the hosts of mosaic are eradicated in so far as possible one season, the work of eradication of host plants is reduced for successive years until complete eradication is attained and future work will consist only in guarding against reintroduction of the disease.

Recommendations for the Control of Cucumber Mosaic in the Field.

1. Cucumbers should not be planted continuously on the same land and the fields should be located at a distance from the farm buildings and vegetable garden. If the cucumber field is surrounded by other clean cultivated crops it will greatly increase the chances for control of mosaic.

The isolation of the cucumber field is very important because it has been found that the wild cucumber, milkweed and ground cherry are frequently found around farm buildings and that mosaic plants of these species are more likely to occur near garden plots as a result of earlier infection from cultivated plants.

Rotation is advisable in order to avoid the accumulation of mosaic hosts about the field. Observations show that most mosaic milkweeds and ground cherries are found on land which has previously grown

cucurbits. The wild plants are first infected from the cultivated host and then serve as sources of infection in succeeding seasons. Rotation is also important in the control of other cucurbit diseases. Where cucumbers are surrounded by cultivated crops such as corn, the number of wild hosts is reduced by the ordinary cultivations and there are also likely to be fewer insects present.

2. All plants which are known to carry mosaic should be removed from the field itself and from all land within at least fifty yards. This includes the wild cucumber, milkweed, pokeweed, physalis and catnip. All of these plants do not always occur in a given locality but all should be removed, whether mosaic or not, if they occur. Frequent inspections should be made throughout the season in order to see that all fresh shoots or plants that appear are promptly pulled.

In the case of the wild cucumber which is annual, the plants can readily be pulled out by the roots. In the case of the milkweed, physalis and catnip it has been found that, if the shoots are pulled out and all later shoots removed as soon as they appear, the plants will eventually die out. These plants are generally deep rooted and where they occur in large numbers it is a difficult task to dig out all the root system. Pokeweed plants have large roots and these should be cut down well into the soil and the surface of the roots covered with salt.

It is essential that frequent inspections be made of the field and surrounding land at intervals of 5 to 8 days in order to remove all fresh shoots of mosaic plants and also to remove new plants which may appear during the early part of the season. Perennials like the milkweed will sometimes fail to produce shoots until late in June or early July and it is therefore important that the inspections be carried on regularly throughout the season. Our experience has shown that after the initial eradication the average field requires only 5 to 10 hours work per season to insure the removal of all wild host plants.

3. Since the mosaic disease is spread by insects from the wild to the cultivated host and also thereafter in the field, it is important that the field be dusted or sprayed to keep down aphids and the striped beetles.

4. When mosaic cucumber plants appear, especially early in the season, they should be removed at once from the field. It is particularly important that this be done during June and July.

The above methods have proven successful under field conditions, even without the use of any insecticides. It has also been shown that the disease can be controlled without any great effort or expense on the part

of the grower. In our own experience the chief difficulty lay in the fact that it was almost impossible to get the average grower to make any real effort at the removal of wild host plants from his fields.

Suggestions regarding plans for a demonstration on the control of cucumber mosaic.

As indicated above, it will be necessary that the growers concerned be given a clear idea of the essential facts regarding the overwintering and dissemination of mosaic before the work is undertaken. It is usually hard to convince the grower that weeds are concerned with the loss of his crop from mosaic.

1. Selection of Farms for Demonstrations.

(a) Avoid fields with heavy brush along fence rows and those near woodlots, brush-covered pastures or small streams. Such locations make the work of eradication uncertain and difficult. Many of the failures of the eradication method of control have been due to the planting of fields adjacent to woods or hedges where poke-weed and other wild hosts have been abundant.

(b) If a single field is used in any locality endeavor to have it located at a distance from other cucumber plantings. A distance of at least one-quarter of a mile is desirable. If it is desired to use more than one field at any point it is highly desirable to have all the fields in a group. The work of eradication will then cover considerable ground which is adjacent to all the fields concerned and the chances of success are increased to a certain extent.

(c) Avoid fields which are located on the outskirts of small towns if the fields are likely to be surrounded by adjacent garden plots. Such a location offers many more chances of outside infection and the survey of gardens and grounds around buildings presents some difficulties in the case of some owners.

2. Rotation of Crops.

(a) Assuming that the demonstrations will be carried out only on farms where cucumber mosaic has occurred, it is very important that the grower be induced to plant his cucumbers on land which has not recently grown cucurbits. If the field can be located in the center of a field of corn or other cultivated crops the chances for the control of the disease will be greatly increased. We have evidence which indicates that such measures have often reduced loss from mosaic even when no other precautions were taken.

In a field where cucumbers have been grown in previous seasons and mosaic has occurred, the milkweeds, physalis, pokeweeds and other host plants both in and near the field have in most cases become infected with mosaic and constitute a reservoir of infection which makes

control more difficult. Moving the pickle crop to another part of the farm may get away from most of the diseased wild host plants and greatly simplify the work of control.

3. Eradication of Wild Host Plants.

(a) See that the growers concerned are familiar with all the wild host plants which occur in the locality, preferably by showing either fresh or preserved specimens or by colored posters. The wild cucumber, milkweed and pokeweed are commonly known, but the wild ground cherry is often found hidden to some extent by other vegetation and is not as well known. We have little data on the occurrence of the latter host in Michigan, but do know that mosaic wild cucumbers, milkweeds and pokeweeds are common.

(b) The first survey and work of eradication should be made before planting but as nearly at planting time as possible in order to allow the appearance of as many weeds as possible before it is undertaken. The inspection should be as thorough as possible and should include as much of the surrounding land as time permits, but ought to cover a radius of 50 yards as a minimum. Generally only a few mosaic plants will be found but care should be taken to remove all plants of the species concerned in overwintering.

(c) After the first inspection the ground should be gone over every week, giving particular attention to spots where perennial mosaic hosts were earlier noted. If the shoots of such plants are pulled out carefully the first time, they rarely develop again from the same roots for a week or two and as the season progresses there will be few new shoots from any of the perennial hosts. The grower should not be depended on entirely but the work should be carefully watched by the person conducting the demonstration, since thoroughness in this case is absolutely essential to success. Actually, there is little effort required to clean up around the average field if one covers only a reasonable area extending 50 to 75 yards in all directions.

4. Use of Insecticides.

(a) In the successful control experiments at Rockland, Wisconsin, none of the growers made use of insecticides and no efforts were made to dust or spray the fields concerned. It has been found, however, that the use of insecticides will aid in controlling the disease, particularly nicotine dust which seems to be more or less effective against both the striped beetle and cucumber aphis. The aphis is the great factor in both the introduction and dissemination of disease in the field and any control measures in this direction are of importance. Our experience has shown, however, that the average grower does not ordinarily fight insects. The results in our Wisconsin work were secured without the use of insecticides and they are therefore not necessarily essential to the successful control of mosaic.

5. Removal of Mosaic Plants.

(a) The grower should be informed regarding the appearance of mosaic on young cucumber plants and should be urged to remove all such plants as soon as they appear. The field should be inspected for mosaic at least once a week at the time it and the surrounding areas are gone over for the destruction of wild host plants. Actually, most of this early inspection work can be done in the course of the necessary cultural operations. The removal of mosaic plants early in the season will often result in delaying the progress of the disease in fields where it has already affected a number of plants, but after the plants have become intertwined it is a detriment rather than an aid. In removing mosaic plants which are intertwined with adjacent healthy plants the unavoidable breaking of leaf surfaces will usually result in infecting one or two more plants for each one removed. Under these conditions the plants should be cut off near the soil and allowed to die where they are.

(b) In localities where cucumbers and especially cantaloupe plants are grown in cold-frames and transplanted to the fields, it is especially important to make certain that all mosaic host plants are removed from the vicinity of the cold-frames. In several instances, severe field infection, not only of the field set with cold-frameplants, but of nearby fields planted with seed, have resulted from the presence of mosaic pokeweed in or near the cold-frames.

In undertaking a project of the above type it will be necessary that someone work with the grower to a considerable extent, at least until the grower is found to be carefully watching the situation and taking the necessary precautions. It would seem advisable, therefore, that care be taken not to lay out too much work in any one county unless considerable help is available. Unless the work is done very thoroughly, it is not likely to succeed, although, as said before, it is possible to handle a single field with only a few hours extra labor each season when one understands the situation to be met.

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WITH THE STATES

California.

In a letter of November 22, Dr. W. W. Mackie, Associate Agronomist in Charge of Cereal Investigations, writes as follows:

"The recleaning and copper carbonate treating equipment used in San Luis Obispo County has just completed a successful fall campaign. This machine was demonstrated at the Grain Growers Convention at San Luis Obispo in September. Another excellent equipment is doing equally efficient work in the hands of Hoefling Bros., Chico, Butte County, Calif. Several of our warehouse men have perfected machines which are doing good work. We hope that this is just the beginning of an excellent piece of work which will eventually eradicate all poor seed and smut from our grain fields."

Colorado.

"We are contemplating carrying on a smut prevention campaign on the Western Slope this spring. The crops which we will cover will be spring wheat, oats and barley," writes Extension Agronomist Waldo Kidder.

Florida.

Farmers, local railroad officials, and representatives of the American Railway Express Company attended a series of 10 meetings scheduled by county agents during the period November 28 to December 6 for the purpose of discussing the relation of plant diseases to the transportation and marketing of fruits and vegetables. Mr. E. F. DeBusk, Citrus Pathologist-Entomologist, talked on careful handling as a means of reducing transportation losses in citrus fruits. Dr. H. R. Fulton, Pathologist, U. S. Department of Agriculture, gave an illustrated talk on citrus disease control as related to marketing. Mr. F. C. Meier, Extension Plant Pathologist, U. S. Department of Agriculture, exhibited lantern slides illustrating the relation of plant diseases to transportation and marketing problems. Photographs recently obtained on the New York market were used in this work.

Indiana.

From Mr. Charles Gregory, Pathologist in Charge of Extension work in Purdue University, we have the following statement:

"It may interest you to know something of the success that we have had this year in our sweet potato certification work. The C. & E. I. club boys all used seed from the same grower. This seed

was from a field that was quite free from the disease last year. This year the potato fields that I inspected show that where this seed was planted on new land, it is practically free from wilt."

. . . . . .

"I am just finishing up a rather successful season on the corn root rot demonstrations. I have demonstrated this to about one thousand farmers. I made good use of the stalk test as a means of introducing the subject of field selection of seed corn to control root rot."

Iowa.

On returning to Iowa after several years spent in China, R. H. Porter writes "Most of my work consisted of experimental research dealing with plant pathology. We were able to start extension work while I was there, which I believe will help out in that country."

New York.

Dr. M. F. Barrus has taken leave of absence for the purpose of studying opportunities for extension work in plant pathology in Porto Rico. Writing from San Juan on November 7, he told of a pleasant trip from New York.

North Carolina.

Estimates received from county agents and local copper carbonate dealers indicate the use of approximately 1,400 pounds of the dust, which should have treated seed wheat for from eight to ten thousand acres this year.

G. W. Fant, Extension Plant Pathologist.

Ohio.

A. L. Pierstorff will begin work as Extension Pathologist in Ohio January 1. Dr. Pierstorff, who formerly was in charge of the plant disease control activities carried on by the special field assistants in New York, has been doing excellent work with the spray service program as Extension Horticulturist in New Jersey.

Virginia.

County agents from the trucking sections will meet with representatives of the Virginia Truck Experiment Station, state extension service and U. S. Department of Agriculture on January 25,

for the purpose of discussing plans for an extension project on cucumber mosaic control. Meetings of growers will follow this conference.

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Articles, news notes, or suggestions with regard to subjects that might profitably be discussed in this news sheet, should be addressed to:

F. C. Meier,
Extension Plant Pathologist,
Bureau of Plant Industry,
U. S. Department of Agriculture,
Washington, D. C.